John Clay Esq

On the Sewage

Treatment

Birmingham

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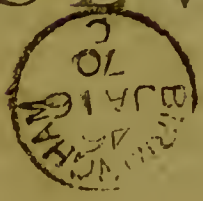
OF

SEWAGE,



BY

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TREATMENT OF SEWAGE.

THERE is perhaps no subject occupying at the present moment more general attention than the question how the Nuisance created by draining our Towns into rivers is to be obviated. The nuisance has arrived at such a pitch as to necessitate a change in the present system, and the choice of means for remedying the present state of things is restricted to one of two methods: that of irrigation; or that of defecation by chemical means, that is, the precipitation of the impurities in an insoluble compact form by some chemical agent.

That irrigation can be employed with great advantage to the soil under certain conditions has been proved beyond doubt at Edinburgh and elsewhere, but the necessary conditions for ensuring success are not universal; foremost amongst which I place a porous gravelly soil. Even where irrigation has been apparently a great success, it is still an open question in my mind whether the success has been complete. That the land can be and has been immensely increased in value is beyond question; but it is under circumstances where the purification of the water is a matter of secondary importance; where the water can be turned on to the land at pleasure, as may suit the crops, and its subsequent state is a matter of no consideration. Where in fact sewage is used as a fertilizing agent and there is no imperative reason for purifying it. I know of no instance where the land has been used as a perfect and continued filter and remunera-

tive crops have been grown. The plan of precipitation of the impurities has not yet to my knowledge been put before the public in a practicable, readily worked form; my present object is to point out a plan patented by myself by which I believe it to be perfectly practicable to defecate sewage in any quantities, and in such a way as to render the outflowing stream perfectly clear and innocuous, and leave a considerable profit from the precipitate for working expenses even putting the value of sewage at a lower estimate than has yet been put upon it.

I propose describing the manufacture and use of my agent and its *modus operandi*; showing the yield to be expected from a given quantity of sewage and drawing a comparison between the economical use of the solid precipitate as a manure, and what I consider to be under the irrigation plan its lavish hap-hazard application. The agent I use as a defecator is sulphate of alumina together with common lime I use the sulphate prepared in a rough way on a large scale by mixing common clay with sulphuric acid in the proportions by weight of two of clay to one of acid. The addition of about the same bulk of water as acid helps the kneading of the mass. After the clay and acid are well mixed, (this can be readily done by steam worked rollers) I place the mass in a warm place, such as an oven or brick furnace and leave it exposed to a gentle heat until the acid has combined with the alumina of the clay, which combination will have taken place by the time the mass has become perfectly dry and of a greyish hue. In order to use this defecator I allow the sewage to flow into a large tank and add the defecator in the proportion of one pound of the preparation to every one hundred gallons of sewage or about four tons to the million gallons. After agitation all the sulphate of alumina contained in the prepared clay is dissolved out, and if the sewage is alkaline, as sewage generally is a small proportion of alumina is precipitated and slightly defecates the sewage. In order

more fully to develope the action of my agent, I then add common lime well mixed with water, in the proportion of one pound of lime to every four pounds of the sulphate of alumina, and agitate the whole bulk of liquid so as to distribute the action of the defecator evenly. On the addition of the lime a chemical combination takes place between the lime and the sulphuric acid of the sulphate of alumina, and the alumina is set free as a flocculent precipitate. This settles to the bottom and inthe art of precipitation adheres to and carries down with it the impurities contained in the sewage, leaving a clear bright supernatant liquid, which requires no further treatment or filtration after settling. The clear water is then run off by means of an opening in the tank a few inches from the bottom, and a fresh supply of sewage run into the tank to be treated in the same way as the first. This process is to be repeated until a sufficient quantity of the precipitate is obtained for drying, the precipitate being stirred up each time with the fresh sewage. The drying may be effected by running the precipitate into a large reservoir formed by excavation of the ground, allowing it to dry by evaporation and absorption of the water into the soil, or the product may be dried by centrifugal force. When dry the precipitate is fit for use as manure. The size of the tank must of course depend upon the quantity of sewage to be treated. For a town of 40,000 inhabitants I should recommend the use of two tanks each capable of holding one million gallons. This would require a tank 150 feet long by 50 feet wide and 20 deep; where this depth cannot be obtained an additiona superficial area must be used, but practically I believe that this depth will be found to answer best. Allowing 40 gallons per day for each individual this will give for 40,000 inhabitants one million six hundred thousand gallons to be treated. Probably the actual amount of water finding its way into the sewers would not equal the total supply as a considerable quantity must be wasted in each household and for watering gardens, &c. The sewage after treatment in the tank should be allowed to remain at rest for about eight hours before

being racked off. The tanks should be constructed with two openings both capable of being closed at will, the one flush with the bottom of the tank, for the removal of the precipitate, the other in the case of a tank twenty feet deep about two feet from the bottom to run off the clear water.

I have mentioned above that on the addition of the lime to the sulphate of alumina in solution a precipitate of basic alumina takes place, which is the active defecating agent in my process. In order to explain this action I will enumerate the properties of clayey soils as shown by Way, the peculiar properties of which I have no doubt depend upon alumina in an insoluble form. Clay consists of a silicate of alumina, with other bodies chiefly iron which take no part in the properties shown by clay. It is only where alumina enters into the formation of a soil that these properties are shown,in other words where clay to some extent is present. In Muspratt's Chemistry the following passage occurs, "Thompson first pointed out the power possessed by soils in arresting salts of ammonia, and Way has extended the same observation to all the mineral constituents which serve as food for plants. He found that without exception the bases of the alkalies and alkaline earths were removed from their acids and retained by soils, the acids such as sulphuric and hydrochloric passing away in combination with lime. There was a remarkable exception in the case of phosphoric acid which never passed away like sulphuric acid but was retained by the soil, though presented in the form of a soluble alkaline phosphate. In prosecuting these enquiries to find out what constituents of the soil possessed this extraordinary power he asserted that it was due to clay alone. Hence sandy and gravelly soils not possessing a sufficiency of clay might be expected to be less retentive of manure. The experience of all farmers proves this fact such sandy and gravelly soils being said by them not to hold manure. On such soils manure requires to be applied more frequently and in smaller quantities

than on stiff clay soils, which have the power of retaining the manure for several crops." Mr. Way has further shown that the mere agitation with clay of water charged with organic and saline impurities is sufficient to remove a considerable portion of such impurities. These properties of clay I believe to depend entirely upon its component ingredient alumina, as alumina especially when finely divided as a chemical precipitate exhibits them in a highly magnified form. If any other salt of alumina than the sulphate, be used and the basic alumina be precipitated by the addition of a stronger base to the solution, this attraction of alumina for organic matter is equally shown, a fact well known to dyers who use it as a mordaunt. I have been led to make choice of the sulphate of alumina as the easiest and cheapest way of procuring a soluble salt of alumina, and lime as the best agent for presenting the insoluble alumina to the action of the organic matter contained in sewage, but other bases can be found to answer the same purpose, amongst which I mention chalk, and carbonate of potash or soda.

One great advantage to be looked for in the use of alumina as a defecator for sewage is the fact that there is no destruction of the valuable properties as a manure of the precipitate. There is no chemical decomposition of the organic matter; I believe the action to be one entirely of adhesion or retention. Just as in the soil, the clay retains the salts necessary for the nourishment and growth of plants, so also in the use of my agent does the alumina retain the organic matter and salts necessary to form a valuable manure. No decomposition or chemical action takes place in either case which affects the manure as food for plants, but a simple retention of the substances which nourish, and these plants have the power of absorbing and appropriating in their growth It is simply a question of superior adhesion, just as in chemistry we meet with instances of superior chemical affinity, where many chemical substances show a preferential affinity for certain other compounds or bodies. The cost of the

material I put down at about £2½ a ton, allowing a margin for profit supposing the material to be purchased and not made on the premises. One million gallons requiring four tons would therefore cost to defecate £10 as the price of the material to be used. From several experiments I have made I am led to expect a yield of 50lbs. of solid manure for every thousand gallons of sewage, making the yield for one million gallons amount to about twenty-two tons. In making my experiments I have used sewage from the tanks, so that in calculating the yield of solid manure from a given quantity of sewage, I am not taking into consideration the coarser impurities, such as cinder dust, road sweepings, &c., which are deposited at the bottom of the tanks, but am simply calculating the more finely divided and valuable portions of matter which are now carried away in the outfall water. There are at present no data for estimating the commercial value of the solid precipitate, but taking the theoretical estimate of chemists of its value, as the basis for calculation (two pence a ton for the raw sewage water) we obtain thirty-five pounds as the value of one million gallons reckoning 240 gallons to the ton. As the yield from one million gallons is twenty-two tons this would represent the precipitate as worth about 32s. a ton. This is a price far below any sum that the solid precipitate from sewage has yet been sold for, but I believe by my process a very considerable profit may be realized at a price even considerably below this. In a tabulated form

No. of gallons of sewage treated.	Yield of precipitate.	Cost of treating.
1,000,000.	22 Tons.	£10.

I have made no estimate of the cost of plant in the calculation but should think that an outlay of two thousand pounds would be ample for providing all that is necessary, viz., two tanks and a small steam engine. The working expenses need be very small as very little manual labour will be required, especially where a good fall into the river or stream can be obtained so as to do away with pumping.

A point which may possibly strike some as an objection to the general use of my plan, is the supposition that there will be some difficulty in disposing of such large quantities of manure as will be produced if it were in use throughout the kingdom. Let us see how figures will tell upon this part of the question. I have said above that the daily yield to be expected from a town containing 40,000 inhabitants is in round numbers about thirty tons of solid manure. This will give about a pound and a half as the daily contribution of each inhabitant. (I have probably here over-estimated the average daily waste of each individual, as I have calculated on the whole forty gallons supplied to each individual finding its way into the sewer, thus giving 1,600,000 gallons to be daily dealt with, whereas I believe 1,000,000 to be more likely the quantity, thus reducing the daily contribution of each individual to one pound.) Taking the united population of the towns of England at twenty millions and supposing that the waste of two thirds of these could be collected and used under the proposed plan, the result would be the production of about nine thousand tons per diem of manure available for agricultural purposes; about three million tons per annum. There would be no difficulty in applying this apparently large quantity of manure to the soil, as the estimated sale of artificial manure averaging the price of seven or eight pounds a ton, reaches half a million tons per annum. The present use of artificial manure is no doubt much restricted by its high price: the increased consumption of sewage manure might no doubt be expected if offered at so low a price as 30s. a ton or even less, notwithstanding the conservatism of farmers and their antipathy to any reform: and a six or sevenfold consumption is no great increase to expect under the proposed alterations in price.

In contrasting the two methods of disposing of sewage, that of irrigation and that of defecation, supposing it to be proved that the solid constituents can be precipitated in the manner

and at the cost I have shown, the advantages must be greatly on the side of the defecating plan. Under the system of irrigation the manure can only be applied in an extremely diluted form and the land deluged with water, perchance at times when no moisture is required. The application of the manure to growing crops of roots is prohibited for fear of washing away the soil round the roots. The choice of the land to be manured must be restricted to the neighbourhood of towns, and is limited to those where a level surface can be obtained, unless pumping be resorted to which has not yet been made to answer pecuniarily. The character of the soil is also another subject for consideration, as heavy lands will not admit of any continued irrigation. The application of manure on the dry plan admits of much nicer and more exact management: it can be applied when and where wanted, and its use more economically arranged The quantities of manure used on the irrigation plan are enormous. Take the published accounts of the Lodge Farm for last year. During twelve months 360,000 tons were used upon 120 acres of land. This represents according to my estimate of 50lbs. of solid matter to each 1000 gallons of sewage no less than two thousand tons of manure as applied to the 120 acres or about sixteen tons per acre in the year. Supposing the manure to be worth anything like the estimate I put upon it, 30s. a ton this would represent no less a sum than £24 an acre as spent upon manure, or £2880 for the 120 acres, and the value of the crops given in the same account is only put down at £3,200, leaving £320 to pay rent and all other expenses and yield a profit. These figures tend to show that if the estimate of chemists of the value of sewage is correct, the farmer does not get the full value from his manure and uses it in a lavish way. The last point upon which I wish to touch is by no means the least. When sewage is run on to land, after the land has been sufficiently saturated, the flow is stopped and the deposit of solid matter which has accumulated is allowed to undergo decomposition by exposure to the air. The emanations from this decomposing mass must certainly exercise a deleterious

effect on the surrounding neighbourhood. Mr. Bailey Denton in a letter to the *Times* on the 24th October, 1869, has ably shown that these emanations are not only unpleasant but have increased the death rate where irrigation has been had recourse to. I think that the medical profession generally will endorse his remarks as to the deleterious effects of what he aptly calls excrement sodden in populous neighbourhoods. Under the defecating plan all decomposition is immediately arrested by the alumina: no unpleasant smell can be detected in the manure produced by this plan. The effect is the same as that produced by the use of dry earth on the dry earth closet system. The defecating system also possesses the advantages of being readily and easily worked, with an inexpensive plant, and can be put into action in the neighbourhood of any town regardless of any consideration of soil or surface level, and if generally adopted will be the means of supplying the farmer with manure the value of which may be calculated by millions, and all of which is now wasted, lost, and thrown into the sea poisoning our rivers and streams in its transit.

Since writing the above observations I have heard it remarked that my process is a mere repetition of other plans which have already been tried and abandoned as impracticable on a large scale. The only two processes which at all to my knowledge approximate my plan are Bird's and the A.B.C. Allow me to point out very material differences between both these plans and my own, letting me premise that I had arrived at my present ideas respecting the conjoined use of sulphate of alumina and lime some time before I had heard of either of the plans mentioned and had communicated my ideas on the subject to Mr. Gulson then Mayor. Bird makes use of sulphate of alumina; after adding the sulphate of alumina to the sewage he allows the mass to settle and then racks off into another tank where he treats the partially cleared sewage to a second dose of the sulphate;

finally after a second settling, filtering through animal charcoal in order to obtain clear water and to remove the spare sulphate of alumina. There are here two very essential points of difference between this process and mine. The first of these is the absence of the use of any alkali except such as already exists in sewage water from the use of soap, &c. Without the presence of an alkali or carbonate of an alkali sulphate of alumina exerts no action on sewage, it is only by the precipitation of the insoluble alumina that any defecating effect is produced. This can be readily shown by neutralizing the alkalimity of sewage by the addition of free sulphuric acid until the sewage shows an acid reaction and then adding sulphate of alumina, when no perceptable action can be noticed, the sulphate of alumina simply remains in solution; but on the addition of any base such as lime, potash, soda, or ammonia a copious precipitate of alumina takes place and the sewage is very quickly cleared. In Dr. Bird's plan a certain defecation takes place but only dependent upon the amount of alkali contained in the sewage, and this is not sufficient to precipitate a sufficient quantity of alumina to produce its defecating effects in such a way as to render the water clear or to collect in an insoluble form the valuable materials contained in the sewage. It is the basic alumina which is the active agent and not the sulphate of alumina. Again the use of animal charcoal must be a mistake both on account of its expense and the constant labour required to keep any fine filter of this kind in action. A filter of charcoal would very soon get blocked up, if largely used as must be the case if used for clearing sewage and the charcoal would then be useless unless reburned which could only be done at great expense. Even such filters as are in use at the Coventry works, consisting simply of large loose stones require to be washed and cleaned every now and then, and a finer filter would last but a fractional part of the time that these may be used for. According to my plan I do away with filtration altogether, being able to get a clear result without it.

The A.B.C. process consists in the use of a defecator containing alum, blood, clay and charcoal, with the optional but not imperative use of one or two other ingredients in small quantities. From the proportionate quantities of the ingredients as given in the specification I put down the clay as the active agent in this mixture. I have already pointed out that clay is a defecator, but maintain that it owes its action to alumina, and that alumina alone shows the same properties but in a highly magnified form. I go to the fountain head and use alumina. The alum and charcoal I consider to be useful in the A.B.C. plan in order to help the precipitation of the insoluble impurities, and to assist in fixing and retaining the ammoniacal salts of the sewage, and this result I believe to be effected by the precipitation of basic alumina by the charcoal, (the lime of which combines with the sulphuric acid of the sulphate of alumina in the alum.) This object I consider to be better achieved according to my plan. I confess my ignorance as to what possible beneficient action the blood can have, except supplying a small quantity of alkali which may be done in a much nicer and cheaper way. I have not seen the A.B.C. plan in action but believe it to be quite practicable to precipitate the impurities of sewage on this plan but look upon my process as cheaper and more easily managed.

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